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## Computer assisted formative assessment: supporting students to become more reflective learners

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## **COMPUTER ASSISTED FORMATIVE ASSESSMENT: SUPPORTING STUDENTS TO BECOME MORE REFLECTIVE LEARNERS**

Denise Whitelock

### **ABSTRACT**

e-Assessment is being advocated in the UK as our way of introducing a more personalised learning agenda throughout the Higher Education sector. This paper discusses the findings from two projects where formative e-assessment has contributed to students taking more control of their own learning.

One study set out to provide further insights into the role of electronic formative assessment and to point the way forward to new assessment practices, capitalising on a range of open source tools. The guiding vision was to pilot a series of formative assessments which have the potential to help shape learners as independent thinkers, making their own judgements and decisions about their learning in partnership with their peers and tutors.

Other work consisted of evaluating a series of formative assessments given to Philosophy students. Lessons have been learned about the type of feedback that instructors and students think will be most useful and how using this type of application promotes self reflection.

The research reported here starts to illustrate how technology can be adapted to become more 'fit for pedagogical purpose'. The feedback offered by these systems encourages learner metacognition and aims to empower students to reflect and become independent thinkers. This approach sits well within a constructivist paradigm which has often been less well served in the past through formal summative assessment which is not an integral part of the knowledge construction process.

### **KEYWORDS**

Electronic formative assessment, science, philosophy, feedback, reflection

### **INTRODUCTION**

Over the last ten years, learning and teaching in higher education have benefited from advances in social constructivist and situated learning research (Laurillard, 1993). In contrast, assessment has remained largely transmission orientated in both conception and in practice (see Knight & Yorke, 2003). This is especially true in higher education where the teachers' role is usually to judge student work and to deliver feedback (as comments or marks) rather than to involve students as active participants in assessment processes.

Recent research recognises that the role of the student in assessment has been under-theorised. It has been acknowledged that students do not learn through passive receipt of teacher-delivered feedback. In fact the work of Boud (2000), Gardner (2006) and Sadler (1989) illustrates that effective learning requires students to actively decode feedback information, internalise it and use it to make judgements of their own work. Other work such as the findings from the FAST (Formative Assessment in Science Teaching) [<http://www.open.ac.uk/science/fdtl/>] and Whitelock (2006) draw attention to the notion that self-assessment is integral to the students' use of feedback information. Nicol & Macfarlane-Dick (2006) also argue that formative assessment processes should actively be designed to 'empower students as self-regulated learners'.

The JISC funded e-Assessment Roadmap (Whitelock & Brasher, 2006) reviewed current policies and practice relating to e-assessment across the UK. It identified a vision for 2014, through desktop research and consultation with experts. A pedagogically driven model for e-assessment was called for rather than a technologically and standards led framework dominating future developments in this area. The vision called for students taking more control of their own learning and to become more reflective when using future e-assessment systems. In fact there was a stronger move towards andragogical (Knowles, 1970) rather than pedagogical principles with recognition that the tutor's role will inevitably change in this new regime and require more support.

The positive effects of immediate feedback to the student through e-assessment was stressed by over half of the papers presented at the recent 2006 CAA Conference. Practitioners, who were advocates of e-assessment emphasised the advantages of feedback to student learning, which can scaffold learners' self regulation strategies which is in keeping with UK education policy which wishes to enhance self reflective learning through e-assessment.

The public examination bodies have also made progress with the development of e-assessments and it was the Northern Ireland Council for the Curriculum, Examinations and Assessment that took the lead in the UK with respect to piloting summative e-assessment. Their action was in compliance with the Northern Ireland's Department of Education document 'A Strategy for Educational Technology' (1997) p.14. Discussions with Edexcel began in 2000 and were followed by a phase 1 pilot study known as the paperless examination (see CCEA/Edexcel 2001, Paperless Examinations project Phase 1 report <http://www.ccea.org.uk>). Phase 2 of the project began in 2002 where a computer-based mock examination in the three sciences, Biology, Chemistry and Physics together with another discipline, namely Geography was undertaken.

More recent research undertaken to explore the acceptance and usage of e-Assessment for UK Awarding Bodies has been reported by Chapman (2006). He found that 38% of the Awarding Bodies surveyed (N.B. 81% of all awarding Bodies responded) use e-Assessment to deliver up to 60% of their assessment programme. The key benefits are ease of administration and time flexibility, together with improved accessibility for students. However candidate authenticity is still an important issue but seven out of ten respondents believed that e-Assessment will deliver on their Return on Investment (ROI). Hence the disadvantages traditionally associated with e-Assessment such as cost and technical issues have decreased in importance as usage has increased. There is now a move towards harnessing the technology to introduce a more personalised learning agenda throughout the Higher Education sector in the UK. The DFES (Department for Education and Skills, 2005) document 'Harnessing Technology: transforming learning and children services' states that "using technology to streamline assessment procedures and enable online assessment on demand is a long term objective". The Department also see ICT supported assessment playing a more formative role in the learning process. They advocate "assessment for learning, not just for judging". The two studies reported in this paper belong to the CAFA Project (Computer Assisted Formative Assessment Project) based at the Open University in the UK and set out to provide further insights into the role of electronic formative assessment and to point the way forward to new assessment practices capitalising on a range of open source tools. The guiding vision was to pilot a series of formative assessments which have the potential to help shape learners as

independent thinkers, making their own judgements and decisions about their learning in partnership with their peers and tutors.

The Project built upon the promise that assessment and learning need to be properly linked. Elton and Johnston (2002) maintain that 'if one changes the method of teaching, but keeps the assessment unchanged, one is very likely to fail': and Rowntree (1987) argues that 'if we wish to discover the truth about an educational system, we must look into its assessment procedures'. The work was also influenced by theories about the function of feedback in assessment for learning. Feedback (Gibbs & Simpson, Nicol & Macfarlane-Dick) and the role presence can play in sustaining motivation to engage in group problem solving activities for students studying at a distance.

The two strands of the CAFA project which are reported in this paper set out to provide further insights into the role of electronic formative assessment and to point the way forward to new assessment practices, capitalising on a range of open source tools. The guiding vision was to pilot a series of formative assessments which have the potential to help shape learners as independent thinkers, making their own decisions about their learning in partnership with their peers and tutors.

## **COLLABORATIVE FORMATIVE ASSESSMENT FOR SCIENCE STUDENTS**

This strand of the project set out to build and test a screen sharing application that would assist with the development of complex problem solving formative assessments for science students studying remotely. The idea being that if students are given tasks to complete where 'two heads are better than one' and are encouraged to work collaboratively at a distance, then they need to be able to screen share a simulation if working in a science domain. The pedagogical driver here was to promote reflection by encouraging students to adopt a 'Predict, Look and Explain' modus operandi around a simulation that has well documented pedagogical benefits. The simulation chosen was Global Warming; see Whitelock & Rae (2005).

Global Warming introduced the students to a model of climate change. The simulation introduced the students to a number of variables that could be manipulated by them within this program. Any changes made resulted in a decrease or increase to the global mean surface temperature of the earth. In effect, this software environment was a simulation which encouraged the students to interact with the variables, understand their sensitivities and appreciate how a change in one variable results in changes to the others (i.e. coupling).

Students who had previously used this simulation alone found it an invaluable aid to their learning in a science foundation course (ibid.) Student A reported in a survey of 200 students that "*With Global warming allowed interaction – could change values and see the effect they had, rather than being 'shown' the effects as with video. Interaction encouraged me to experiment with different values which were not covered on the exercise.*"

Since this science application had a proven track record, it was then incorporated into the SIMLINK tool which facilitated screen sharing for a given simulation.

### **Brief description of the tool**

SIMLINK is a JAVA based downloadable plug-in which forms part of the BuddySpace family of communication tools. It allows users at a distance to work on a joint simulation together. They can view the same screen. This means when one student makes a change to the simulation, the other sees this change. In effect they are working together and viewing identical representations on their monitors, as they would if they were working side by side. This is achieved by sending mouse click changes only from one partner's application to the other. This avoids bandwidth problems and time delays that 'raw' screen sharing would entail. Figure 1 below illustrates the variables such as levels of carbon dioxide and water vapour, cloud cover, ice and snow, aerosol content, solar constant and albedo that can be manipulated by the students to change the earth's temperature.

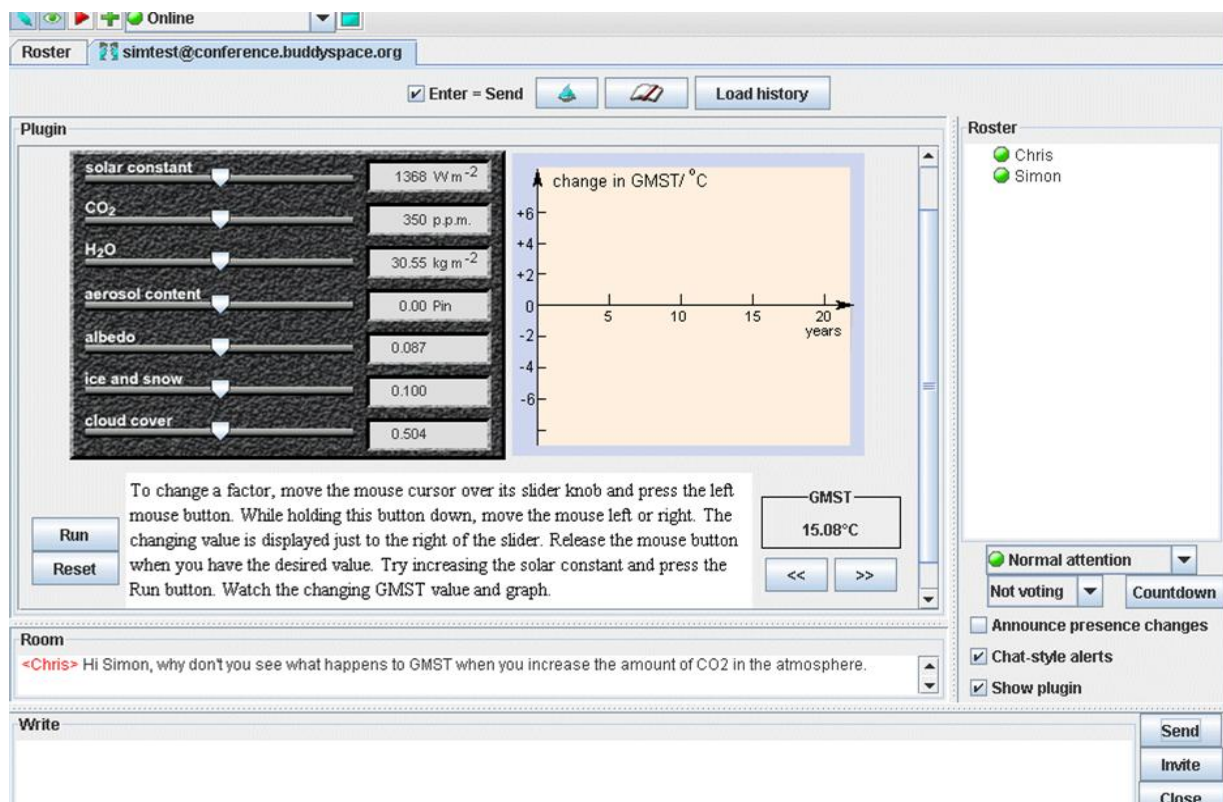


Figure 1. Screen dump of Global Warming interface

Fourteen volunteers, who were not science students, but had some background knowledge of science, took part in the pilot study. This cohort was chosen, as an extreme test case since if they could manage the technology and learn some of the science at the same time, then this pedagogical package should be made available to course teams to use at the University.

The users were able to work together in separate rooms using the SIMLINK software together with BuddySpace (an open source JAVA application which is an instant messaging environment for community building with online presence indicators). This meant that the users could manipulate the environment on their screens and any changes would be available to their partner by the SIMLINK application while the BuddySpace program facilitated the communication between the two remote users.

### Main findings from the evaluation

The users were all given a pre test to ascertain their knowledge about global warming before they used the simulation. They quickly became engaged in the topic and some heated discussions took place about how to solve the problems they were given during their time together online. See Figure 2 for an example of two users working together with SIMLINK. They were asked to establish which variables have a cooling factor on the global mean surface temperature of the earth, conversely to establish which variables have a warming effect and to ascertain what would happen to the global mean surface temperature when major events such as a volcanic eruption took place. A post test was administered after users worked with the simulation and the cognitive change scores i.e. the difference between the pre and post test scores, showed an increase. In fact the cognitive change score for the group was  $5.8 \pm 1.1$ .

The users also completed a follow up questionnaire and 60% believed that this type of formative assessment exercises not only assisted with learning, but also provided a sense of community and belonging for distance learning students. One user commented that she needed time to reflect on what

was happening but felt pressurised to respond more quickly as she imagined the other person waiting for a response. However she did concede that once you get to know your partner this was not so much of a difficulty. Working collaboratively forced the students to make explicit their reasoning behind their decisions to alter certain variables and they believed they overcome some of their initial misconceptions about the topic. Discussion also helped them to make sense of the feedback given by the Global Warming simulation. The important take-home message from this development is that these types of interactive assessments do promote reflection and the technological pull is starting to address the pedagogical push for designing holistic e-assessment.



Figure 2. Two users working collaboratively with a shared screen at a distance using the Global Warming application

Scientists and Mathematicians have led the way in both designing and implementing both formative and summative e-assessments. They have often been the pioneers in this field often gaining research funds to start new initiatives in their respective universities (Whitelock et al 2006c). In contrast academics from the Arts faculties have been more reticent to embrace e-assessment which has often been viewed, in its present form, as only suitable for disciplines where there are clear correct answers to a set of questions about a given phenomenon. However the challenge of designing electronic formative assessments for formal logic has been undertaken at the University of Aberdeen <http://www.abdn.ac.uk/philosophy/PaulTomassisiOnlineLogic.shtml> and for Philosophy at the Open University. The latter development is discussed with respect to promoting student reflection on their own learning and the types of enquiries that are made after using these e-assessments.

## FORMATIVE ASSESSMENT FOR PHILOSOPHY STUDENTS

It was the AA308 course “Thought and Experience: Themes in the Philosophy of Mind” that trail blazed the use of formative e-assessment in the O.U.’s Arts faculty. This course developed a set of over 50 formative electronic assessment questions to assist their distance learning students to become more



reflective learners. The main driver for this particular development came from the faculty itself which had already identified the need for a substantial development in the use of formative interactive assessment. The following advantages of using online assessment as a means of delivering formative assessment were cited:

- A change from the traditional Self Assessed Questions found in the set texts and electronic assessment provides a more varied learning experience for the students
- More likely to be fun to use and to enhance the learning experience through self monitoring and reflection
- Helpful in increasing student motivation and, ultimately, retention
- Suitable for a range of abilities
- Can be used flexibly, both as consolidation material and as a revision tool for exams
- Allows for more interactive learning and encourages more active student participation
- More students now are attuned to an online learning environment and expect the Open University to keep abreast of technological development

The course was divided into five major sections which explore the following topics:

- Aspects of Mind
- Emotion
- Language and Thought
- Imagination and Creativity
- Consciousness

The questions were designed to encourage students to reflect upon these five topics as they were introduced to them in the set texts. Students were supported to explore a number of philosophical definitions and concepts in these exercises, which they could then build upon when writing up their course assignments. Examples of the types of questions are illustrated in Figures 1 and 2 below.

**AA308 Book 4: Imagination and Creativity - Microsoft Internet Explorer provided by The Open University V 6.0 ...**

Address <http://www.open.ac.uk/Arts/aa308questions/intscr4.htm> Go

main menu

**9. Combinational, Exploratory and Transformational Creativity**

In Chapter 6 Margaret Boden's distinction between exploring and transforming conceptual spaces - or generative systems - is discussed. In the interview with her on CD4, she stresses that her considered view is that there are three forms of creativity: combinational, exploratory, and transformational creativity. Which of the following exhibits combinational creativity, which exploratory creativity, and which transformational creativity (on Boden's account)?

	Combinational	Exploratory	Trans-formational	
(1) Kekulé's discovery of the benzene ring.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
(2) Schoenberg's atonal music.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
(3) Coming up with the idea of a unicorn.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	✓
(4) Goodyear's discovery of vulcanization.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
(5) Mozart's piano sonatas.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
(6) The development of non-Euclidean geometry.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	✓

FEEDBACK ANSWER CHECK

← →

Figure 3. Online question from Imagination and Creativity after CHECKing

The aim of presenting these questions in this format was to convert a previously passive experience for the students into an active one. A variety of question styles such as Drag and Drop, fill in the missing gaps, were used to keep the attention of the students. The questions were an optional part of the course which had 426 students following it in 2005. The number of times the questions were accessed during this presentation of the course is recorded in Figure 4 below.

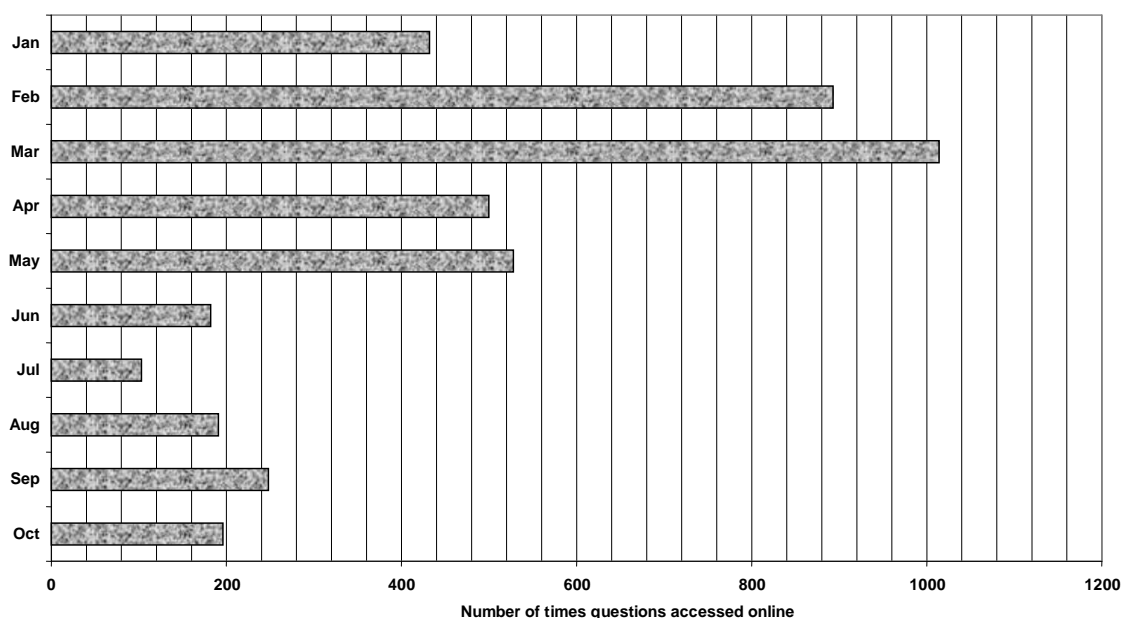


Figure 4. Number of times the questions were accessed per month on the online exercises

The bar chart above illustrates that students used the assessments more at the beginning of the course when they felt they had more time. This is because the formative assessment is optional. A set of follow up in-depth interviews with ten students revealed that for some there was such a volume of course material that they missed out on anything that was optional in order to save time. One student said *“the thing that is difficult is when something is optional – I mean, how optional is it?”* However those that used the system revealed that the questions were a good stimulus to promote interaction with others such as their tutor, the internet and other students in order to clarify their misunderstandings. In other words, this type of formative assessment was revealing to students what they did not know. They then had time to reflect on the gaps in their knowledge and form a strategy of how to resolve their difficulties.

Half the students questioned mentioned that they used the questions for revision purposes and that these formative assessment tasks were most useful for the Imagination and Creativity topic and they assisted them to complete their tutor marked assignments. Being able to repeat the questions a number of times was found to be very helpful. However having access to online chat with another student would have been preferable.

### What do the tutors' think?

There were positive responses from the tutors. For example, tutor A remarked *“My sense of the students as a whole is that they are tremendously receptive and that they are much more receptive than people believe them to be.”* While another mentioned, *“The online format certainly allows for more interaction and for a more varied and entertaining learning experience.”* 60% of the tutors interviewed believed that the students became more reflective if they used the formative assessment questions. The evidence



that they cited was the number of queries that they received and also a change in the quality of student discussions. They too recognised a difference in the quality of the tutor marked assignments they received from students who had used the online system.

### **Summary**

The first steps in providing electronic formative assessment exercises to a subject within the Arts Faculty of a distance learning university have been taken and although limited have achieved a degree of success, especially in promoting self reflection and students taking control of their own learning. One of the problems with the assessment in this type of course is that in many cases there is no absolute answer. Questions are therefore designed to encourage the students to consider the issues more deeply and any text entries would have had to have been hand marked if a summative mode of assessment had been employed. However the writing of questions can be a positive experience for tutors since it encourages them to see the subject from different angles associated with the different question formats.

### **CONCLUSIONS**

One of the major findings of the CAFA project is the creativity of staff, both academic and technical, to create formative e-assessments with systems which provide a restricted repertoire of questions and feedback to students. The development process is time consuming and costly and fewer students benefit from these electronic formative assessments when they are an optional extra in the course. It is recommended that electronic formative assessment becomes a compulsory element of any course's teaching materials. Learners have been shown to welcome the instant feedback afforded by electronic assessment, which can also be used by tutors to diagnose student misconceptions of a given topic.

It might appear in the short term that the technological pull and restrictions imposed by V.L.Es is currently overtaking the pedagogical push in the e-assessment arena but a collection of open source applications have been explored by the CAFA project and serve as a way forward to redress the balance. Examples include a BuddySpace, BuddyFinder and SIMLINK.combination which can assist students working remotely to collaboratively make predications before they answer a series of formative assessments tasks, which focus around the use of a simulation.

The two very different applications of e-assessment reported in this paper indicate the potential of e-assessment to significantly enhance the learning environment and the outcomes for students in a wider range of disciplines and applications. The research reported here starts to illustrate how technology can be adapted to become more 'fit for pedagogical purpose'. The feedback offered by these systems encourages learner metacognition and aims to empower students to reflect and become independent thinkers. This approach sits well within a constructivist paradigm which has often been less well served in the past through formal summative assessment which is not an integral part of the knowledge construction process.

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